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HURRICANE EVACUATION BEHAVIOR

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Researchers have conducted sample surveys following at least twelve hurricanes from 1961 through 1989 in almost every state from Texas through Massachusetts. The resulting database is larger than that for any other hazard, and many generalizations are feasible concerning factors accounting for variation in response to hurricane threats.

Risk area and actions by public officials are the most important variables affecting public response. When public officials are aggressive in issuing evacuation notices and disseminate the messages effectively, over 90 percent of the residents of high-risk barrier islands and open coasts evacuate. People hearing, or believing they hear, official evacuation advisories or orders are more than twice as likely to leave in most locations. A greater percentage of mobile home dwellers evacuate than occupants of other housing, especially in moderate-risk and low-risk areas. General knowledge about hurricanes and hurricane safety is weakly related or unrelated to evacuation, but belief that one's own home is subject to flooding is strongly associated with whether the occupant leaves. Length of residence in hurricane prone areas and hurricane experience are not good predictors of response. The great majority of people who evacuate unnecessarily in one hurricane will still leave in future threats.

INTRODUCTION

In 1900 a hurricane struck Galveston, Texas and killed 6,000 people, the greatest single event natural disaster in United States history. Losses of that magnitude have not been approached in recent decades, primarily as the result of improved warning and response systems. The National Hurricane Center monitors and forecasts storm behavior and warns officials and the public of threats. Many residents of coastal areas respond by relocating from their residences to sites which they believe will be safer, whether across the street or 150 miles inland.

Not everyone always evacuates, however. Documenting and explaining variations in response have interested researchers since at least the mid-1950s when Killian surveyed residents of Panama City, Florida after hurricane Florence threatened the city (1954). Many beliefs about hurricane evacuation behavior held by researchers, emergency management professionals, and others stem from findings in nonhurricane or early hurricane studies at best and from anecdotes at worst. A database of sufficient size and geographical scope now exists, however, to draw many firm conclusions about hurricane evacuations. The hurricane evacuation database surpasses that for any other hazard and should enhance the understanding of evacuation behavior more generally.

Empirical Studies

Table 1 lists the principal studies documenting how coastal residents have responded in past hurricane threats. They cover twelve different hurricanes (see Figure 1), but some of the studies documented response in multiple locations in the same hurricane. The Gloria study, for example, included up to four cities in each of eight states from Virginia through Massachusetts. Locations of the survey sites are shown in Figure 2, with multiple markers indicating more than one survey in the same location. Sample sizes in each survey site mentioned in Table 1 numbered at least 100, and most were substantially larger. All of the studies followed hurricane threats and consisted of interviews with residents of the threatened areas. In some of the studies, the threatening hurricane hit the survey area, while in others it missed. The storms themselves varied in severity, and the locations varied in their past hurricane history, economic activity, demographics, hazardousness, and how officials responded during the threats. Respondents in the surveys were asked questions about their actions during the threat and about other variables which might serve as predictors.

More specialized or limited works have dealt with one or more aspects of hurricane evacuation and are used in this analysis to supplement those in Table 1. Killian's 1954 work following Florence and Bates et al.'s (1963) study of Audrey are examples.

Hurricane hazard perception studies *per se* are not included, although hurricane awareness and beliefs about the hazardousness of one's homesite will be discussed as possible predictors of evacuation behavior. Several surveys have asked coastal residents how they would respond in a hypothetical hurricane, and they are largely excluded from this analysis. There are occasional notes, however, pointing out conflicts or consistencies between actual and hypothetical response studies.

Table 1. Primary Empirical Studies of Hurricane Evacuations

Citation	Storm	Year	Location
Moore et al., 1963	Carla	1961	Texas Calhoun Co. Galveston Baytown Chambers Co. Louisiana Cameron Parish
Wilkinson and Ross, 1970	Camille	1969	Harrison Co., MS
Windham et al., 1977	Eloise	1975	Ft. Walton Beach, FL Panama City Beach, FL
Baker et al., 1977	Eloise	1975	Panama City, FL
Baker, 1980	Frederic	1979	Grand Isle, LA Pass Christian, MS Pensacola, FL Panama City Beach, FL
Leik et al., 1981	Frederic David	1979 1979	Mobile, AL Miami, FL
Treasure Coast Regional Planning Council, 1983	David	1979	Martin, St. Lucie, Indian River Co.'s, FL
Baker, 1981	Allen	1980	Galveston, TX
Baker, 1984a	Alicia	1983	Galveston, TX
Baker, 1985	Diana	1984	SE North Caroline Myrtle Beach, SC
Baker, 1986	Elena	1985	Pinellas Co., FL Panama City, FL
Nelson et al., 1988	Elena	1985	Tampa Bay, FL
Baker, 1988	Gloria	1985	Virginia Newport News Eastern Shore Norfolk Virginia Beach Maryland Crisfield Ann Arundel Ocean City Denton Delaware Bethany B. Millsboro New Jersey Ocean City Bradley B. New York Rockaway Westhampton B. Connecticut Fairfield Groton Rhode Island Warwick Newport Massachusetts Wareham
Baker and Carter, 1990	Elena	1985	SE Louisiana
Baker, 1990	Hugo	1989	South Carolina Beaufort Charleston Myrtle Beach

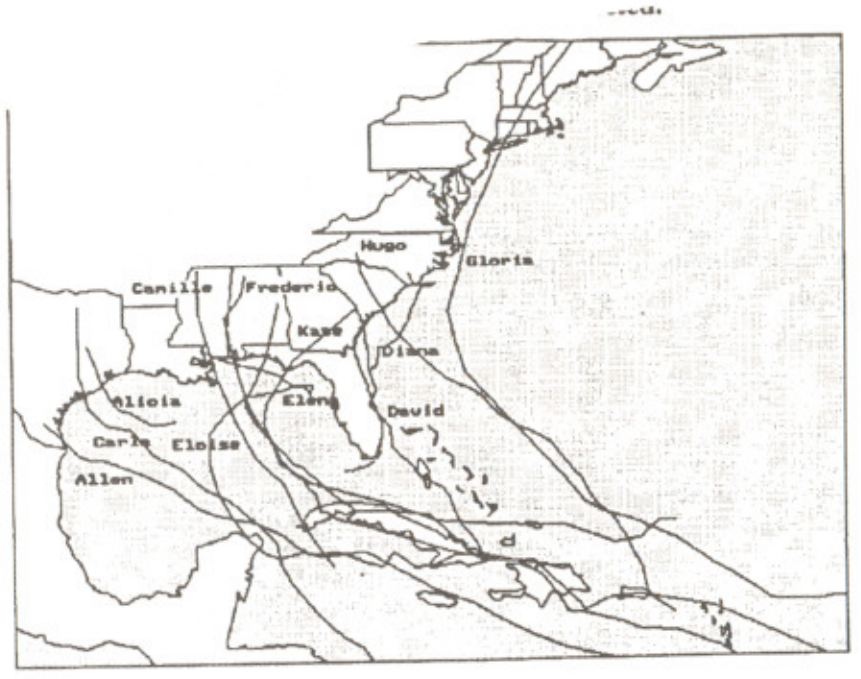
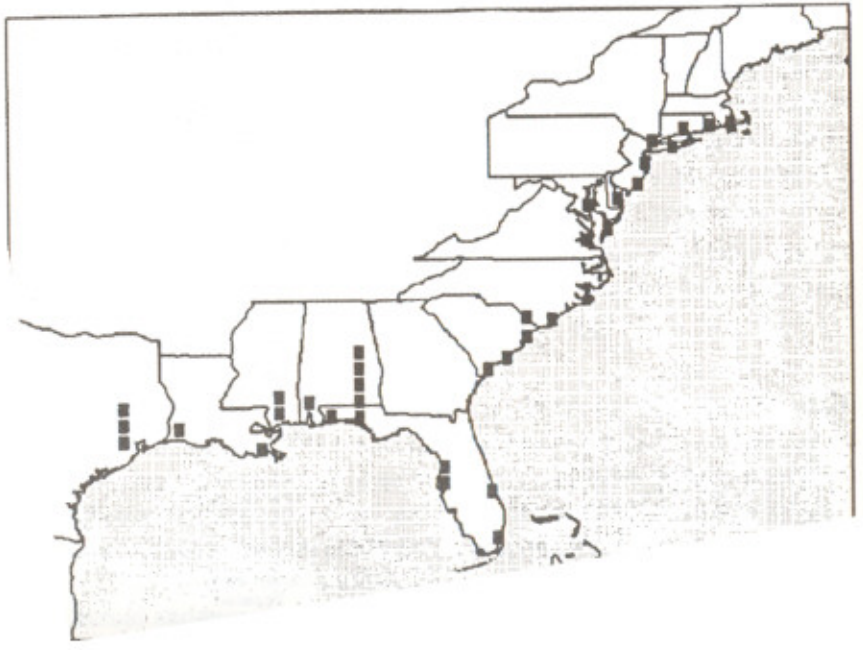


Figure 2. Sites where post-hurricane response surveys have been conducted.



Procedure and Conventions

For this analysis the studies listed in Table 1 have been integrated a set of generalizations regarding evacuation rates. Generalizations inc. quantitative descriptions of behavior and an assessment of possible pre tors of whether people evacuate. Synthesis of the descriptive informat stems from a straightforward review and summary of the studies. Asse. ment of the predictors is more subjective. Many variables have be measured for all respondents in all or most of the studies, and a variety analyses has been performed in each study to ascertain their relationship t evacuation rates. In the surveys respondents are usually asked to explai the reasons for some of their behaviors, but one must view self-account data cautiously, as many respondents oversimplify and cannot accurately articulate the intricacies of their decisions. Such data is employed occasionally, however, particularly when there is supporting evidence from other sources and when it appears consistently in significant magnitudes. To avoid repetitious appearance of author-date acknowledgments, most data citations in the discussion refer to the evacuation study by name of storm. Please refer to Table 1 for author-date correlates.

VARIATIONS IN RESPONSE

Evacuation rates vary from place to place in the same hurricane and from storm to storm in the same place. Figure 3 depicts evacuation data from four different survey locations in each of four different hurricanes. In each storm the two locations having the highest documented evacuation rates and the two lowest are shown. Explanations for the variations are discussed in detail later, but it is clear that in some locations almost everyone left while in other locations within the warning area half or less of the population evacuated. Studies which report evacuation behavior in just one small geographical area or which report one figure for a large area can be misleading.

In Galveston 68 percent left in Carla in 1961, 63 percent in Allen in 1980, but only 47 percent in Alicia in 1983 (Figure 4). In Panama Cit... Beach, 87 percent evacuated in Eloise in 1975, only 54 ... in 1979, and 78 percent in Elena in 19... one cautious ab...

Figure 3. Evacuation rates in various locations in four hurricanes.

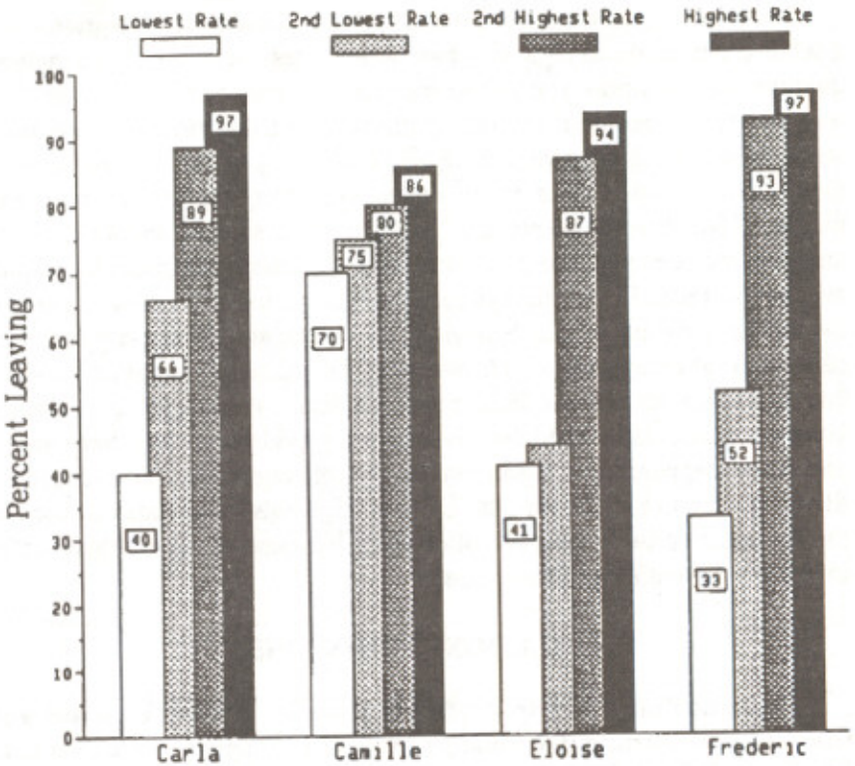
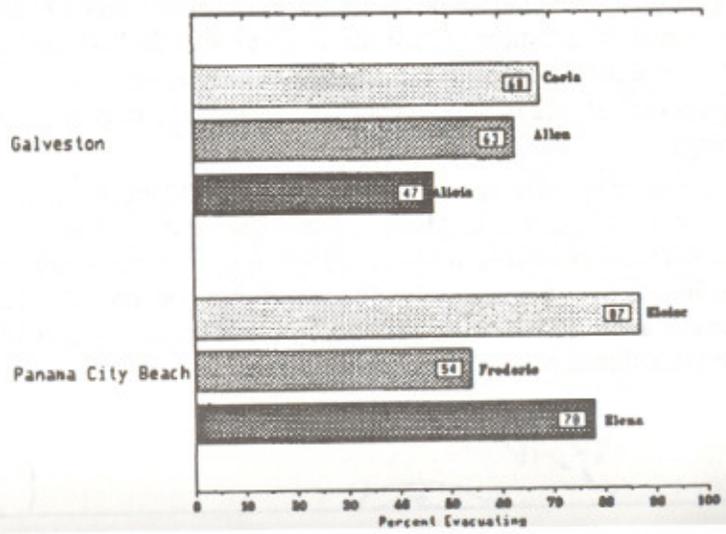


Figure 4. Variation in response from storm to storm in Galveston, Texas and Panama City Beach, Florida.



PREDICTORS (AND NONPREDICTORS) OF RESPONSE

Given the examples of variation in response cited above, it is natural to wonder what accounts for the variations. Much effort has been devoted to explanation of hurricane warning response differences, sometimes with surprising and frustrating results. Many "intuitively obvious" variables are notoriously poor at predicting whether people evacuated.

Self-accounts

A simple approach to explaining why some people leave and others stay is to ask them, and virtually all evacuation studies have done that. It is very difficult or impossible for people to accurately articulate their decision-making methods thoroughly, but this most superficial of approaches provides a starting point and certain useful insights.

Most residents who feel unsafe staying where they are during a storm tend to leave, and those who feel safe tend to stay. For example, in Diana 60 percent of the North Carolina mainland residents who evacuated said they did so because of the severity of the storm. Fifty-five percent (some giving more than one reason) indicated they left because they were convinced that the storm would or could strike their area. Most of those who stayed said they did so because they felt their location would be safe. Those responses, with minor variations, are typical of those found in survey after survey. The challenge is to explain why some people feel safe while others don't.

Also mentioned frequently are evacuation notices from public officials or their representatives. These notices serve in many cases to convince people that the situation is dangerous, but some residents probably respond because they tend to be obedient to authority figures or think there is a legal penalty for noncompliance. Still others say they leave because of appeals from friends and relatives. Again, these appeals sometimes contribute to the evacuee's determination that staying would be dangerous, but at times residents leave to appease someone else even if they don't agree with others' assessment of the risk.

When stayers are asked why they didn't evacuate, they offer a variety of explanations in addition to saying they felt safe where they were. Three reasons cited frequently for not evacuating are that respondents wanted to stay behind to protect their property from the storm, protect their property from looters, or fulfill obligations to their employer. Occasionally stayers indicate that peer pressure from neighbors who didn't evacuate impeded their own leaving. There is also the overall inconvenience or effort involved

with evacuating: gathering things to take; arranging for a place to stay; imposing upon others; providing for pets (which aren't allowed at Red Cross shelters); fighting the traffic often accompanying evacuations; and enduring the discomfort and environment of public shelters. Less than five percent usually state that they had no transportation or no place to go.

No doubt the above are factors which coastal residents often consider in deciding whether to evacuate during a hurricane threat. But the list, as presented and as stated by respondents, is of little value in predicting before the fact just how extensive an evacuation will be.

The following variables are potentially more useful in making *a priori* forecasts of evacuation rates. One group could be labelled situational variables: the physical hazardousness of a person's residence and information concerning the specific threat (notices from public officials, proximity of the storm, and so forth). The other variables are individual-difference factors: hurricane experience, hurricane awareness, length of residence in the area, past evacuation behavior, and demographics (age, income, education, family status).

Risk Area

Low-lying sites exposed to open water are more dangerous than sites at higher elevations even a few city blocks inland and protected by offshore barriers. Typically high-risk sites are barrier islands or open coastlines with elevations less than 10 feet above mean sea level. Low-risk sites are usually on the relatively protected mainland, over 15 or 20 feet in elevation. In between are moderate-risk sites, on the protected mainland but no more than 10 to 15 feet high, often flood-prone in strong hurricanes.

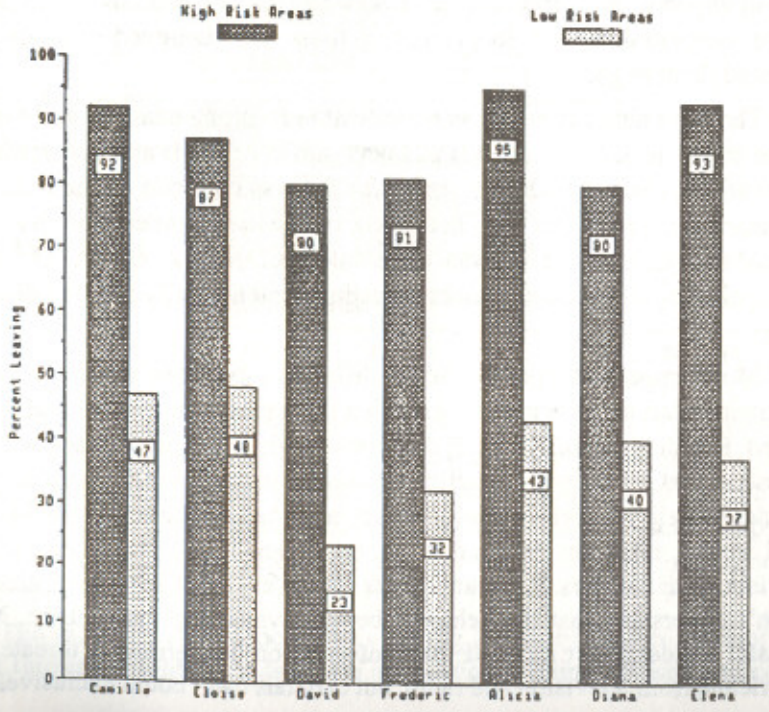
Fortunately, evacuation from high-risk areas is usually very good. Figure 5 compares evacuation rates from proximal high-risk and low-risk areas in seven hurricanes. Evacuation rates from the seven high-risk areas depicted in Figure 5 averaged 83 percent, compared with 37 percent in the seven nearby low-risk areas. The precise values of the rates are not as important as the fact that the rates are so notably different. Whether because residents of high-risk areas are aware of the hazardousness of their locations or because public officials make greater efforts to evacuate the residents of these areas, it is clear that those who most need to leave are those who are most likely to do so.

From a policy standpoint, emergency preparedness planners have traditionally been understandably preoccupied with maximizing evacuation rates from high-risk areas. Moderate-risk areas, while certainly safer than

high-risk locations, are also sometimes subject to inundation by storm surge, and evacuation rates in these areas is usually between 55 and 65 percent. It appears that moderate-risk areas deserve more attention from officials than they have normally received in the past, given their vulnerability to flooding and their relatively low response rates.

Evacuation rates in low-risk areas pose a different sort of policy dilemma. The great majority of residents in these locations would be safe in their own homes in all but the most severe hurricanes (the most notable exceptions being mobile-home dwellers). In low-risk zones near the coast between 20 and 40 percent of the residents often evacuate, contributing to traffic congestion and increasing the time necessary to clear evacuees from high-risk and moderate-risk areas. The phenomenon is sometimes referred to as evacuation "shadow," in which evacuation from high-risk and moderate-risk areas appears to influence response in nearby areas not necessarily needing evacuation. Advising low-risk area residents to stay put throughout a threat is a legally risky and ethically uncertain proposition. Officials are more likely to issue evacuation notices for high-risk and moderate-risk areas and then simply try to make it clear which areas are affected by the notices.

Figure 5. Comparison of evacuation rates in high-risk and nearby low-risk areas in seven hurricanes.



Evacuation Notices

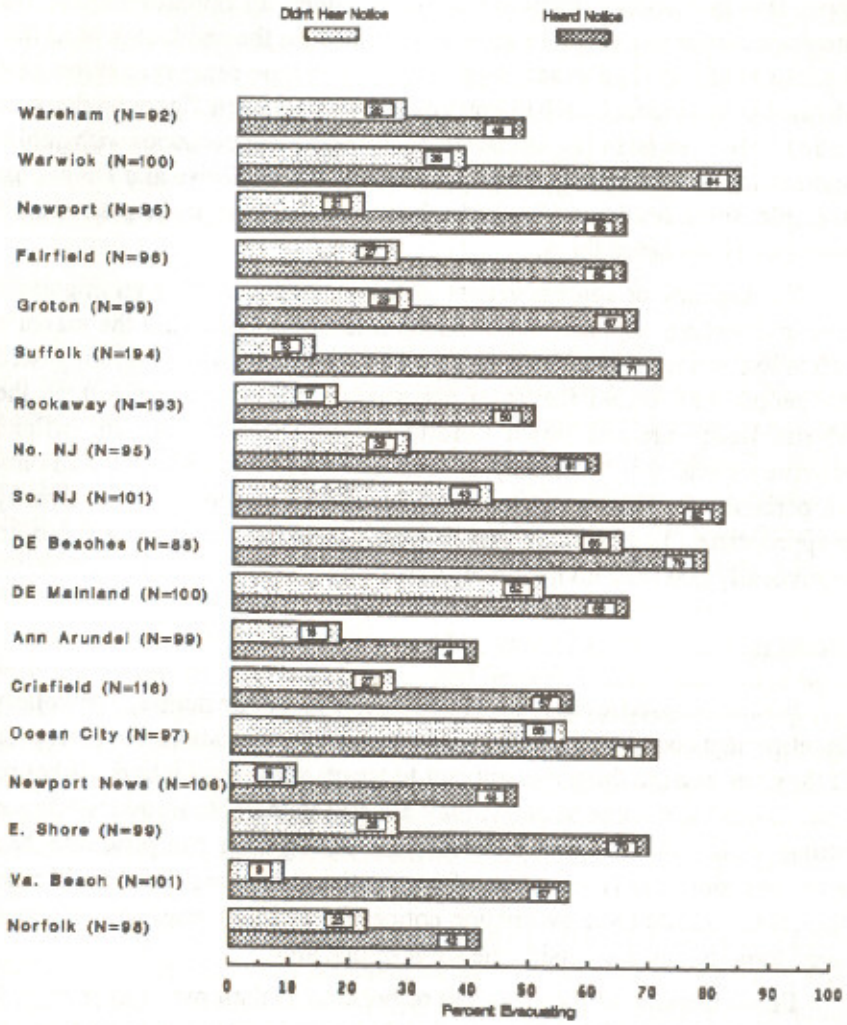
Advice or orders from public officials, and the way they are worded and disseminated, affect evacuation rates more than any other factor, with the possible exception of risk area, although the two variables are confounded. Two illustrations are particularly compelling: In Mobile in Frederic the evacuation rate was only 34 percent in an area closely corresponding to the 100-year floodprone area (a moderate-risk location according to the trichotomy set forth above). In the areas where evacuation was advised, however, 63 percent evacuated. Of the Mobile residents who said they heard from public officials that they should evacuate, 84 percent left; of those who didn't hear, the evacuation rate was only 20 percent. In Miami and Miami Beach in David the difference was even more pronounced. Eighty-eight percent of those who heard they should leave evacuated, while only 8 percent of those who didn't hear they should leave did so. Virtually all of the sample was in high-risk and moderate-risk areas where evacuation was ordered by state and local officials.

Figure 6 illustrates the principle in Gloria, a more recent storm. In each of the survey sites respondents believing they had been told to evacuate were more likely to have left. Overall, they were almost three times as probable to leave. Only 25 percent of those not hearing they should evacuate did so anyway. Fifty-four percent believing officials had advised them to leave evacuated, as did 88 percent of those who believed officials had ordered them to go.

The **legal** distinction between evacuation recommendations and evacuation orders is not as important as many public officials and preparedness professionals believe. Orders are by far the less common of the two, and although most residents who hear recommendations understand that they are advisory, 15 to 25 percent often interpret them as orders. Officials disseminating evacuation notices sometimes intentionally blur the distinction.

More important than the legal difference between an order and a recommendation is the manner in which the notice is worded and disseminated. Residents are more likely to evacuate when they understand without question that an evacuation notice applies to them, and more personalized modes of delivering the message result in higher responses. In the Mobile and Miami examples referred to above, officials had issued evacuation advisories and orders, but many residents either didn't hear the notices or didn't understand that the behavior being advised applied to them. Most coastal residents get most of their information concerning a threatening hurricane from television and radio, but officials can't count exclusively on

Figure 6. Evacuation rates in hurricane Gloria for respondents saying they heard officials say to evacuate vs. those who said they did not.



the media to disseminate evacuation notices if they wish maximum response. Media messages are most effective when they communicate official advisories concerning very specific behaviors and address them to spatially specific locations. Much better use could be made of large-scale maps on television to help viewers identify whether they are within zones being evacuated.

The most effective procedure is having authority figures go door-to-door through neighborhoods where evacuation is being advised and com-

municate face-to-face with residents. This approach minimizes chances that people will misinterpret the message or won't hear it at all, and the authority figure (police, firefighter, etc.) adds credibility as well as authority. Moreover, the face-to-face communication provides an opportunity for the message carrier to explain or answer questions for the resident. Use of this method probably had much to do with the 97 percent evacuation rate attained in Pensacola Beach in Frederic and a comparable figure on the west end of Galveston Island in Alicia. Going through neighborhoods with public address loudspeakers has proved less successful. In Eloise and Diana, for example, some residents of neighborhoods where loudspeakers were used said they never heard them.

The urgency or aggressiveness of the message can play an important role in affecting response. When Alicia threatened Galveston the mayor's office issued a statement that a "voluntary evacuation" was being suggested for people who would feel safer elsewhere. Only 47 percent left. In the Myrtle Beach area of South Carolina when Diana threatened, official statements said that "voluntary evacuation" was recommended, and only 48 percent left. This is not to suggest that either action was necessarily inappropriate. The point is that evacuation notices can be worded so equivocally that they invite nonresponse.

Housing

In many coastal areas many residents live in mobile homes, particularly in retirement communities, and they pose special evacuation problems even if they are outside the zones subject to storm surge inundation. Although "tie downs" add some security, they are still vulnerable to overturning in strong wind, and windblown objects and falling trees can penetrate their exteriors more easily than that of conventional housing. Public officials, therefore, usually issue evacuation notices for mobile homes near the coast even though they are outside the surge-prone area.

Either because of those notices or because of their own recognition of the hazardousness of their homes, mobile home dwellers are more likely to evacuate than other groups. The two studies involving the largest numbers of mobile homes in the samples were conducted in Florida: the Treasure Coast Regional Planning Council study following David and the Nelson et al. survey in the Tampa Bay area after Elena. In the Treasure Coast area 52 percent of the mobile homes dwellers left, compared to only 14 percent of other residents. Seventy-seven percent of the mobile homes were evacuated in the Tampa Bay area, compared to 52 percent of the other structures. Smaller sample studies tend to reflect the same finding. In Delaware in

Gloria the evacuation rate was 75 percent for mobile homes and only 35 percent for other housing.

Less is known about other housing types such as "high-rise" structures. In the Rockaway area of New York, only eight percent of the high-rise residents left during Gloria in 1985, whereas 40 percent of the people in other structures left. In Pinellas county, Florida in Elena, however, high-rise residents were more likely to evacuate than occupants of other structures (excluding mobile homes), 75 percent to 55 percent. In the Pinellas county case, high-rises were more likely to be located near the beachfront on high-risk barrier islands.

Storm Threat Information

During a hurricane threat coastal residents receive information concerning the severity of the storm, its location, whether the National Weather Service has issued a watch or warning for specific segments of coastline, and (since 1983) the probability that the hurricane will "strike" various locations. The information might come from official sources, the media, or friends and relatives. A distinction is made here between threat information and evacuation notices from public officials, discussed above, as the former (threat information) lacks a place-specific behavioral directive.

Several information-related variables, including the following, have been tested and found to be unassociated or very weakly associated with whether a person evacuated: 1) primary source of information during the threat (radio, television, other); 2) source of initial information about the hurricane; 3) attention devoted to monitoring the storm (when first heard about it, frequency of media attention, keeping a tracking chart); 4) confidence in weather and hurricane forecasts; and 5) recall of forecast information.

Belief that the storm will hit is not as strongly correlated with evacuation as one might expect. Weak associations were found in Carla, Camille, and Eloise, but even those associations held true only when the storm was within a few hours of landfall.

Expectation of damage is a better predictor. The distinction between this and the former variable is that residents might be convinced that a storm will strike their area but believe it is too weak to pose a threat to them in their location. In one of the Eloise studies, when respondents believed that winds would be strong enough to overturn autos or that their homes would suffer water damage, they were more likely to evacuate than people who didn't hold those opinions.

The National Hurricane Center issues a hurricane watch when a storm is expected to make landfall within the next 36 hours and a warning when the storm is believed to be within 24 hours of land. The Weather Service does not issue specific evacuation notices, although public advisories issued by the Hurricane Center contain general suggestions that residents of low-lying areas should leave, and local statements from Weather Service Offices make reference to evacuation notices which have been issued by public officials. Watches and warnings alone do not prompt most people to leave. One bit of evidence comes from cumulative response curves, indicating when evacuees left. Sharp upward changes in slope in the curve representing an increase in evacuation rate does not usually follow the issuance of watches or warnings unless evacuation notices are also disseminated.

Watches and warnings apply to 300 or more miles of coastline, giving little indication where within the areas the storm is most likely to hit. Since 1983 the Hurricane Center has included in its public advisories "probabilities of hurricane conditions" for selected cities along the U.S. coast. These are defined as the chance that the eye of the hurricane will pass within 65 miles of each of the cities for which the probabilities are assigned. Before probabilities were made available to the public many meteorologists and emergency preparedness officials expressed concern that the public would not understand the information and that the numbers would actually deter people from leaving when they otherwise would.

Alicia and Diana were the first major storms for which probabilities were issued. Between 70 and 80 percent of the residents in both Diana and Alicia said they recalled hearing the probabilities, the great majority believed they understood the numbers (but thought their neighbors didn't), and almost everyone thought the information was useful. There was no evidence to suggest that the information inhibited evacuation, and evacuation decisions appeared to be based primarily upon other variables such as advice from local officials. For example, almost total evacuation of the high-risk west end of Galveston Island began when Alicia's probabilities for the area were well below .50. Certain high-risk areas of North Carolina also achieved very high evacuation rates; in a survey of 200 Wrightsville Beach residents, 199 said they left in Diana.

Late night evacuations make notification of the threat more difficult, and leaving at night can be more inconvenient and perhaps more dangerous. Time of day has not proven to be a significant deterrent to whether people evacuate, however. It does appear that given a choice, many people would prefer to leave during the day, but many very successful evacuations have been conducted late at night, most notably Eloise in northwest Florida and Elena in the Tampa Bay area.

Storm severity would appear to be important in influencing evacuation, and it probably plays a role. Public officials take stronger action in stronger storms, however, and the two variables are badly confounded. Another problem is that very few response surveys have been conducted following weak hurricanes. The most notable effect is probably in moderate-risk and low-risk areas, where evacuation rates are noticeably higher in stronger storms.

Experimental Data

All the data reported to this point have been documentations of actual self-reported behavior based upon personal interviews conducted after hurricane threats. Although actual response data is generally preferable to hypothetical response data, there are cases in which the latter have some usefulness. One of the problems with actual response data is that the behaviors are in real-world threats in which several threat factors are highly correlated with one another, thereby confounding any assessment of their separate effects. For example, as a hurricane moves closer to shore, the National Hurricane Center is more likely to issue a warning rather than a watch, probabilities will increase, and public officials are more likely to issue an evacuation notice. It is impossible to ascertain statistically, given the high multicolliniarity and relatively few data points, which threat factors account for people's evacuation behavior. Residents themselves are unable to articulate reliably how they weighted each threat factor in their decision.

In 1983 a "pencil-and-paper" experiment was conducted to measure the effect which hurricane probability forecasts and other threat information would have on public response (Baker 1984b). One group of respondents in the St. Petersburg-Clearwater area of Florida was presented with 16 hypothetical hurricane threat situations described in terms of storm severity, storm location, National Hurricane Center "alert" (watch, warning, neither), and local officials' statements regarding evacuation (advised, ordered, neither). Another group of residents was presented with exactly the same 16 threat situations, plus the probability that the storm would affect their area and the probabilities of its affecting other coastal locations. People in both groups were asked whether they would evacuate in each of the 16 situations. The 16 threats were constructed such that the variables involved (severity, NHC alert, etc.) were statistically independent of one another. Binary logic models were calculated for both groups and used to predict evacuation rates in 150 hurricane threat scenarios.

All other things being equal, people used probabilities in precisely the manner the Weather Service had hoped, and evacuation increased as probabilities increased. Realistically combined with other threat information, however, probabilities were found in most situations to have little if any effect on public response, compared to response without probabilities. With or without probabilities, the most important factor was action by local officials. A version of the experiment was conducted in Wrightsville Beach, North Carolina in 1984 with very similar results.

There is the question whether these responses to hypothetical threats bear any resemblance to the real world. An encouraging finding was that respondents were extremely systematic in using the threat information in reaching their decisions; the group models predicted the cell means of responses within five percentage points in all but two threat situations. Respondents were much more likely to say they would evacuate in low threat situations (watch, no notice from officials) than one observes in actual hurricane threats, but expressed evacuation rates in higher threat situations corresponded very closely to what has been documented. More importantly, there is no obvious reason to question the findings regarding the relative importance of the threat factors, even if magnitudes of responses to some threats are overstated.

Hurricane Experience

Hurricane experience is a difficult concept to define and measure, although some cases are clearer than others. Intuitively it seems that previous hurricane experience should affect future response. The conventional wisdom seems to be that people in communities which have experienced major hurricanes "recently" will evacuate in greater numbers than people in communities which have not experienced a major hurricane recently. Supposedly worst of all are people in communities which haven't had a direct hit from a major hurricane recently but have been on the fringes of a bad storm or experienced a lesser hurricane. Those people are supposed to have "false experience." Windham et al. (1977) coined the term "experience-adjustment paradox" in reference to the belief that newcomers to coastal areas would actually be more likely to evacuate than oldtimers because the newer residents had not yet fallen prey to the dreaded "false experience."

Empirically no consistent relationship between experience and evacuation has been documented. Part of the reason might stem from the difficulty in defining and then measuring experience. Early empirical support for the experience-response connection came from hurricane Carla. Cameron parish, Louisiana had the highest evacuation rate (96%) of any location surveyed after the storm, although Cameron was on the edge of the warning area. Hurricane Audrey which had killed 400 Cameron parish residents in 1957 was credited with conditioning the residents to evacuate. However, Cameron parish was the only survey area in Carla where local officials ordered residents to evacuate, so the Audrey effect is not so obvious as many thought (except perhaps indirectly by inducing local officials to issue the evacuation order).

Ninety-seven percent of Pensacola and Pensacola Beach evacuated before hurricane Frederic in 1979, although Pensacola had no recent major hurricane history. In fact there were ample opportunities for "false experience" in near-misses from Camille in 1969 and Eloise in 1975. Evacuation in Frederic was higher in Pensacola than in Panama City Beach which was also in the warning area and had suffered major damage from Eloise. Pensacola's evacuation was also greater than Pass Christian, Mississippi's in Frederic, although Pass Christian had been ravaged by Camille 10 years before. Grand Isle had an evacuation rate comparable to Pensacola's in Frederic despite the fact that Grand Isle was on the edge of the warning area and hurricane Bob, a very weak storm, had struck the island earlier in the summer, providing a golden opportunity for residents to gain "false experience."

This is not to suggest that people don't have false experience. Many certainly do. That is, many people incorrectly think they have been through major hurricane conditions (Leik et al. 1981). The issue, though, is whether those or any other hurricane experiences have a predictable effect upon subsequent evacuation behavior. People have been asked in surveys whether they had any kind of previous disaster experience, any kind of previous hurricane experience, how many hurricanes they had experienced, how recently they had experienced a hurricane, how severe was the hurricane they experienced, how much property damage they had experienced in hurricanes, and whether any family member had ever been injured in a hurricane. Most research has relied upon self-reports of experience. Some has gone farther and recorded where people said they were living in different years and then assigned experience levels based upon meteorological records. None of the measures is generally predictive of what residents did in subsequent hurricanes.

In some evacuations, where data was collected only in high-risk areas, the overall evacuation rate was so high that there was too little variance in the dependent variable for any meaningful test of statistical signifi-
These cases

hypothesis or any other predictor hypothesis. The variance was so small because almost everyone in the sample responded the same way, regardless of differences in experience or anything else. Even if larger samples had produced statistically significant differences in response, the magnitudes would almost certainly have been relatively trivial.

The main reason to expect that experience might affect evacuation behavior is that experience contributes to awareness of the hazard, usually meaning an appreciation of the danger posed by it. There are many ways to achieve that kind of awareness, however, some of which might lead to greater concern than experience.

Length of Residence

Closely tied to the experience-response hypothesis is the notion that people's evacuation behavior depends upon how long they have lived in the coastal area. There are two versions of the idea: (1) Newcomers don't appreciate the destructive potential of hurricanes or know what to do so they are less likely to evacuate than people who have lived there longer and learned to respect the hazard. (2) Very few coastal areas have experienced direct hits by major hurricanes in the past five or ten years, but people living in coastal areas at least that long often believe they have experienced such storms and found them not so dangerous (i.e., "false experience"); therefore, newer residents are actually the more likely group to leave.

There is no consistent evidence for either, although length of residence has been measured and tested against evacuation in several hurricane studies since Camille. Even Windham et al.'s claim of support in Eloise for the "experience-adjustment paradox" isn't upheld by a reanalysis of their own data (Baker, 1979). In the occasional study which has found a difference in response according to length of residence, it has usually been an artifact of risk area. Beachfront high-risk areas are growing faster than other parts of many coastal communities, and newer residents are more likely to move into those areas.

Hurricane Awareness

It might seem that people who know more about hurricanes should be more likely to evacuate than others, but they aren't. Studies have measured the number of National Weather Service hurricane safety rules people can name, number of hurricane terms known, whether people have ever seen a copy of the rules, whether they possessed a copy of the rules, whether they have ever even heard of the rules, whether they know the difference between

a watch and warning, and so forth. People who know more about those sorts of items are no more or less likely to evacuate than people who know less. There are people who know a great deal about hurricanes but are unlikely to evacuate, while there are other people who know hardly anything about hurricanes but might be terrified by them. There is scant evidence as to whether knowing local shelter locations and having given forethought to what routes to use in an evacuation have any bearing upon response.

There is, however, evidence that if people realize that their homesite is hazardous and subject to inundation by storm surge, they are much more likely to evacuate. Leik, Carter, and Clark suggest that warnings and even generally worded evacuation notices only confirm residents' perceptions of their own vulnerability (1981). Thus if a person believes his homesite is safe, he is less likely to interpret the warning or evacuation notice as being applicable to himself.

In Miami and Mobile residents were interviewed in 1977 regarding their evacuation intentions and concerns about hurricanes. In 1979 hurricanes threatened both areas, and as many as possible of the same people were contacted a second time. All respondents lived within the approximate "100-year" flood inundation zone. Of the Miami residents saying in 1977 they believed flooding would be likely in their location if a hurricane struck, 55 percent evacuated in David, compared to only 10 percent who had indicated a belief that flooding would not occur. In Mobile the evacuation rates were 61 percent and 16 percent for the same two groups.

To the extent that previous hurricane experience affects response, this is the likely tie-in. By inundating high-risk and moderate-risk areas, hurricanes show which areas are at greatest risk to future storms, and residents who witness the inundation or its effects are thereby made more aware of the hazardousness of various parts of their community. Different storms (varying in intensity, track, size, and forward speed) will flood divers locations in the same community, however, and are therefore limited in their generalizations

Crying Wolf

Preparedness officials frequently express concern that if people evacuate unnecessarily during a hurricane threat, they won't be willing to leave during the next threat. Officials are therefore reluctant to urge residents to evacuate until it is very clear that the hurricane will severely affect their location. The problem is that population densities and inadequate egress routes dictate that many people evacuate several hours before one can be sure where the storm will hit and how severe it will be. Although this is a

difficult hypothesis to test, there is no empirical evidence to suggest that it creates a major problem. As early as 1954 evacuees who left Panama City in a "false alarm" were asked whether they would be more reluctant to leave in the future, and few said they would. In fact many stayers said they would leave in the future (Killian 1954). In Carla one of the better predictors of evacuation was whether people had evacuated in past hurricane threats; those who had left in the past were also more likely to evacuate in Carla.

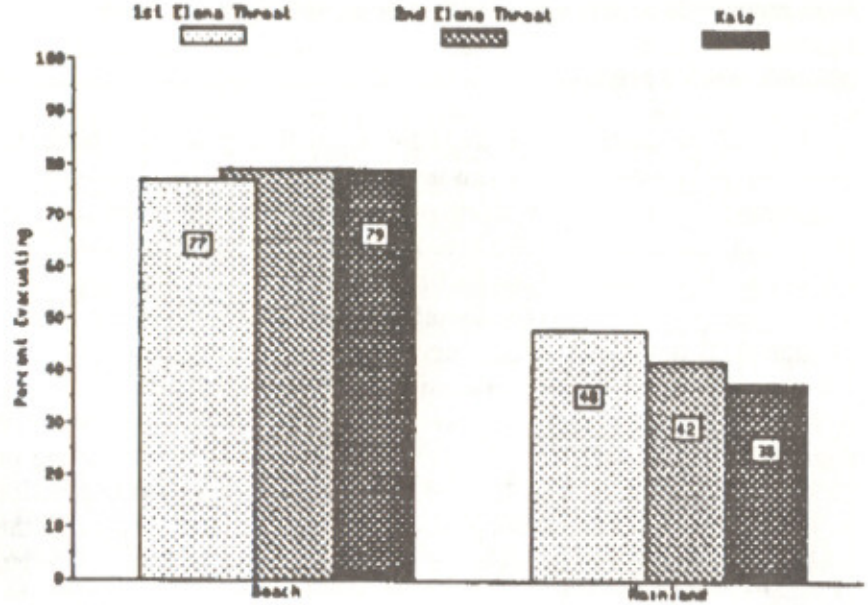
The Galveston evacuation during hurricane Allen in 1980 was extremely early, commencing at public officials' behest even before the Weather Service had issued a watch for Galveston. Allen was an extremely strong storm at the time the evacuation began but never came close to Galveston, weakening and striking south of Corpus Christi instead. Evacuees were interviewed after Allen, and 80 percent said they would do the same thing again, given the same circumstances. Ten percent said they would leave even earlier to avoid the traffic, and 10 percent said they would wait longer next time to decide whether to leave.

After Diana only 5 percent of the evacuees said they would not leave in the same situation in the future. When stayers have been asked why they didn't evacuate, fewer than 5 percent have typically cited previous unnecessary evacuation as the reason.

The 1985 hurricane season provided a rare opportunity to gain insight into the "cry wolf" phenomenon. Parts of northwest Florida westward to southeast Louisiana were evacuated up to three times in different hurricane threats. In Panama City and Panama City Beach, Florida areas were evacuated as Elena and Labor Day weekend approached. The storm slowed and turned to the east, allowing residents in Panama City to return to their homes on Friday and Saturday. On Sunday Elena reversed course, prompting officials to urge evacuation in the Panama City area again. The storm stayed offshore as it moved to the west, missing Panama City once more. In November a very unusual late season hurricane named Kate threatened Panama City still another time, and officials again issued evacuation notices. Kate eventually crossed the coast east of Panama City.

Interviews conducted after the season revealed that on Panama City Beach (the more hazardous area), residents responded about the same way in each threat. Approximately 78 percent evacuated in each instance (see Figure 7). On the mainland, there was a slight decline in evacuation rate over the three threats (48%, 42%, 38%) among those surveyed, but the differences were not statistically significant. Ten percent of the beach residents and 23 percent of the mainland residents *said* they probably

Figure 7. Evacuation rates during three 1985 hurricane threats in Panama City and Beach, Florida.



Demographics

Age is frequently mentioned as a critical variable because of the restricted mobility of older people. Most studies have failed to find an association between age and response, although there is some evidence that elderly residents in retirement areas are more likely to evacuate than other age groups.

There has been speculation that the elderly evacuate in numbers comparable to other groups because family and social networks in Gulf Coast communities where most of the research has been conducted work to "take care" of the elderly and see to it that they reach safety (Steele et al. 1979). There is concern that in retirement areas like south Florida where the elderly don't have benefit of the same family and social ties in the community, their evacuation will be a greater problem. The Miami evacuation in David, and the Pinellas county evacuation in Elena, however, failed to substantiate the concern.

Education is typically not associated with evacuation, nor are occupation, marital status, sex, presence of children (or pets) in the home, or whether the occupant owns or rents the dwelling. Most other demographic variables have too spotty a record to offer any generalizations or are

confounded with other factors so strongly as to make their usefulness suspect. Income, for example is usually correlated with risk area, as beachfront property is usually occupied by people with higher incomes.

Miscellaneous Variables

One of the better things to know in predicting whether someone evacuated is the extent to which his neighborhood evacuated. If most of the neighborhood evacuates, a resident of the neighborhood is more likely to leave than someone in a neighborhood where most people stayed. The traditional interpretation of this finding is that there is a conformity effect. That is, one resident leaves (or doesn't) because the neighbors are leaving (or aren't). This no doubt affects some people, but neighborhood response is badly confounded with risk area and often with actions by public officials. A resident doesn't necessarily leave or stay because his neighbors are engaged in the behavior, but he and his neighbors are often leaving or staying for the same reasons (the neighborhood is subject to flooding, police have gone door-to-door advising evacuation, and so forth). Although the conformity effect probably exists, it is unlikely to be as strong as often claimed.

No other factors which have been tested have had much success. Boat ownership, church attendance, operating home weather instruments, and total number of emergency preparations taken are some of the variables tested.

CONCLUSIONS

Documentations of numerous hurricane evacuations covering three decades have produced relatively consistent patterns concerning whether residents evacuate. Variation is largely accounted for by five variables:

- risk level (hazardousness) of the area
- action by public authorities
- housing
- prior perception of personal risk
- storm-specific threat factors.

Many individual-difference variables, including demographic factors, are rarely, weakly, inconsistently, or never related to evacuation. These include age, previous hurricane experience, previous unnecessary evacuation, general hurricane awareness, age, education, sex, and family status.

Hurricane evacuations have been studied more extensively than those of any other hazard. Reviewing the hurricane response literature and attempting to explain inconsistencies and patterns within it suggests cautions in studying other hazards and in developing more general evacuation behavior models. Researchers should exercise care in generalizing from too few evacuations or from one hazard to another. Despite the large hurricane evacuation database, each new study adds understanding, largely because situational and storm-specific variables change. Generalizations must be qualified in terms of the known specifics of the situations which could restrict the findings' relevance to other situations. Researchers should attempt to ascertain the importance of variables affecting evacuation rather than simply determining whether relationships of any magnitude exist. Early studies in particular reported predictors which have proved relatively unimportant compared to other factors.

The eventual goal of studying evacuation behavior should be production of a truly generic model (i.e., one which will work for any hazard) which can predict magnitudes of change in evacuation behavior given a change in one variable, the magnitude of evacuation given a mix of variable levels, and the relative effects of many variables on magnitude of evacuation. To a large degree this can already be done for hurricanes, but for most hazards current models can only be used reliably to predict directional changes in probability of evacuation when one variable changes at a time.

Perhaps real progress can't be made until the databases for other hazards are as large as that for hurricanes. Certainly much can be done in the meantime to more systematically compare and contrast findings for various hazards with an eye toward the characteristics of hazards themselves which appear to result in different responses and different predictor effects. Efforts to date appear to have concentrated upon identifying similarities in results or inventorying everything which even sometimes affects evacuation, more than explaining differences in the findings.

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